ConservePlants: An integrated approach to conservation of threatened plants for the 21st Century

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Grant Proposal

ConservePlants: An integrated approach to conservation of threatened plants for the 21st Century

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Abstract

Even though plants represent an essential part of our lives offering exploitational, supporting and cultural services, we know very little about the biology of the rarest and most threatened plant species, and even less about their conservation status. Rapid changes in the environment and climate, today more pronounced than ever, affect their fitness and distribution causing rapid species declines, sometimes even before they had been discovered. Despite the high goals set by conservationists to protect native plants from further degradation and extinction, the initiatives for the conservation of threatened species in Europe are scattered and have not yielded the desired results. The main aim of this Action is to improve plant conservation in Europe through the establishment of a network of scientists and other stakeholders who deal with different aspects of plant conservation, from plant taxonomy, ecology, conservation genetics, conservation

physiology and reproductive biology to protected area's managers, not forgetting social scientists, who are crucial when dealing with the general public.

Keywords

in situ plant conservation, *ex situ* plant conservation, conservation genetics, red lists of threatened plant species, citizen science

1 SCIENTIFIC & TECHNOLOGICAL EXCELLENCE

1.1 SOUNDNESS OF THE CHALLENGE

1.1.1 DESCRIPTION OF THE STATE-OF-THE-ART

Even though plants represent an essential part of our lives offering exploitational, supporting and cultural services, we know very little about the biology of the rarest and most threatened plant species, and even less about their conservation status. Rapid changes in the environment and climate, today more pronounced than ever, affect their fitness and distribution causing rapid species declines, sometimes even before they had been discovered (Joppa et al. 2011, Wiens 2016). Despite the high goals set by conservationists to protect native plants from further degradation and extinction, the initiatives for the conservation of threatened species in Europe are scattered and have not yielded the desired results (e.g. Godefroid et al. 2011a, Sharrock et al. 2018, Sharrock and Jones 2010).

Europe is probably the continent which has faced most changes in its ecosystems by past human activities and is today covered with a mosaic of semi-natural habitats and urbanized areas, with only restricted fragments of the natural habitat. Although human activities often increased diversity, species diversity is nowadays rapidly declining due to overexploitation and degradation of habitats. Data indicate that the total number of vascular plant species in Europe is about 10,500 species with about 33% of them being endemic to the region (Silva et al. 2008). The first assessment of Europe’s Vascular Plants by IUCN in 2011 assessed 1,826 species (=17.4% of the European flora) and showed that at least 467 (=25.6%) are threatened with extinction (Bilz et al. 2011). If we include in those numbers the whole Mediterranean basin, which represents one of the global biodiversity hotspots and a larger part of southern Europe, the number would exceed 25,000 with 13,000 endemic species and an unknown but undoubtedly high share of threatened species.

There are several national and international instruments aiming at plant conservation in the European region (Convention of Biological Diversity, Bern Convention, Habitats Directive, CITES, EU Wildlife Trade Regulation, among others). While legally binding documents dictate the need for conserving species, they usually do not specify how conservation should take place. Moreover, conservation of threatened plant species in different countries can follow very different pathways depending on who is leading the conservation actions, which infrastructure is accessible and how much money is available for such actions. This is even more evident in regions or countries where species conservation is not a priority. In some countries, national resources for plant conservation are scarce and conservation is restricted to NGOs, enthusiasts and volunteers. Plant conservation in such countries is often implemented within projects financed from EU or other international funds. The sustainability of such actions is sometimes questionable as the end of a project also means the end of financing.

Another shortage in plant conservation is the lack of scientific basis in conservation planning (Lauber et al. 2011, Wilson et al. 2016). Inadequate knowledge in species biology is one of the most important reasons causing the failure of conservation trials (Heywood and Iriondo 2003). Most plant reintroduction trials for example still do not take into consideration the importance of genetic diversity of the reintroduced material and the genetic relatedness among individuals and populations (Godefroid et al. 2011b). In practice, plant conservation is implemented by different stakeholders (Universities and other academic institutions, NGOs, state institutions), which often act individually and do not follow any specific protocols. This shortage is merely a result of inadequate communication among parties involved in conservation.

Finally, it should be emphasized that plant conservation cannot be successful without the positive attitude and awareness of such topics by the general public. Plants attract much less of the public's attention than animals or environmental issues (Balding and Williams 2016). This can be changed by sharing knowledge about the importance of a healthy environment (of which plants represent an essential part) and the need to preserve it among all age and social groups. Conservationists should also take advantage of the increasingly popular citizen science approaches. Nowadays, technology (e.g. smartphone apps) is considered as one of the main drivers of the recent expansion of citizen science (Sturm et al. 2018), which is offering a new exciting tool that could be potentially used in plant conservation, if done in a planned and scientific way.

1.1.2 DESCRIPTION OF THE CHALLENGE (MAIN AIM)

The overarching aim of this Action is to improve plant conservation in Europe through the establishment of a network of scientists and other stakeholders who deal with different aspects of plant conservation, from plant taxonomy, ecology, conservation genetics, conservation physiology and reproductive biology to protected area's managers, not forgetting social scientists, who are crucial when dealing with the general public (Fig. 1). While conservationists could take advantage from previous experiences of conservation activities, the successes, and particularly the failures of conservation activities, often remain unpublished in peer-reviewed papers or are only published in grey literature, disabling the transfer of knowledge and know-how (Godefroid et al. 2011b, Abeli and Dixon 2016). A platform where plant conservationists could discuss practical conservation actions and their scientific foundation would be valuable (Godefroid and Vanderborght 2011). Such platforms are already available, but are usually restricted to selected countries (e.g. Conservation Evidence in the UK).

Figure 1. doi

Species conservation word cloud.

Another crucial issue in plant conservation is the inconsistency between red list criteria among different countries. In most countries, red list criteria follow the IUCN categories. However, these have changed throughout the years, but national red list categories in some countries still follow the out-dated IUCN categories. This makes it difficult to compare the status of certain species on a local and global scale.

In order to make categories comparable between countries, countries should be encouraged to harmonise their categorisation with IUCN and re-evaluate their species accordingly. This COST Action aims to address the adequate national bodies responsible for red list evaluations by suggesting changes in their categorisation and encouraging the re-evaluation of red species lists.

Plant conservation is a cross-national border activity, but is currently lacking coherence at the international scene. There are large differences between regions and countries within regions in financial resources available for plant conservation, human expertise and know-how, uses of novel technologies, but also in the attitude of the general public towards the importance of conserving plants. All these points will be addressed in the COST Action through transfer of knowledge from countries where conservation is recognised as an important priority to countries in which plant conservation is neglected.

Inadequate knowledge in species biology is one of the most important reasons causing the failure of conservation trials (Heywood and Iriondo 2003). In the recent decades, there has been a massive increase of theoretical knowledge about plant conservation since the know-how to quickly identify the life cycle constraints affecting the species generation turnover is widespread in Europe (e.g., Oostermeijer 2003, Oostermeijer et al. 2003). The species-based approach for plant conservation has been recently re-evaluated by proposing, for instance, SHARP (Systematic Hazard Analysis of Rare-Endangered Plants), a method that firstly pinpoints the bottleneck in the life cycle of rare and endangered species, then identifies reasons causing the bottleneck for generation turnover and finally provides specific indications for conservation actions (Aronne 2017). Potential benefits of this method need to be widely discussed, tested in different environments and, finally, evaluated for application at regional scale.

Plant conservation is often focused on selected populations and not on the species as a whole. Since species do not recognise borders, their treatment is currently fragmented and not comprehensive (and often depending on national legislation and finances). Understanding the genetic makeup of species is crucial when dealing with rare and severely fragmented species. Conservation genetics, and especially genetic monitoring, helps us to reveal why some individual populations are more at risk than others (Van Rossum et al. 2020, Van Rossum and Raspé 2018). The advances in genetic techniques in the past decades have led to the development of a whole new subfield of plant conservation - conservation genetics - which is now being followed by the even more advanced subfield, i.e., conservation genomics. However, the results of these studies are being incorporated into plant conservation less frequently than expected (Mijangos et al. 2014). Also, climate change will affect the genetic adaptation of plants (Thomann et al. 2015), and this will have important management impacts on rare and threatened species, both in the light of in situ conservation and also in reintroduction and/or reinforcement projects. These topics are only starting to emerge in conservation science, and their potential is yet to be investigated. This COST Action will evaluate the potentials of conservation genetics and genomics and will indicate the possible implementation of their results into practical plant conservation. Indeed, the need to put conservation genetics and genomics into practice is being recognised by many experts in the field, including scientists, policy-makers and practitioners.

Knowledge communication across disciplines, into the field of nature conservation, is however still limited. To reduce the local extinction risk of a species, a direct transfer of scientific knowledge into management actions, including a new multidisciplinary community with strong focus on sustainable procedures is urgently needed. Researchers and institutions dealing with different disciplines within plant conservation will benefit considerably when connected into one integrative network. There is also unexploited potential in the inclusion of the general public in gathering data in conservation activities. The developing field of citizen science should be used to help promoting plant conservation through the general public. Citizen science projects focusing on plant conservation should be revisited and finding new opportunities for inclusion of the public in conservation activities could prove beneficial for scientists, citizens and nature.

1.2 PROGRESS BEYOND THE STATE-OF-THE-ART

1.2.1 APPROACH TO THE CHALLENGE AND PROGRESS BEYOND THE STATE-OF-THE-ART

Despite the several legal and binding national and international instruments, threatened European vascular plants require further conservation actions to improve their status. This should be implemented by identifying hotspots of plant diversity within Europe that may then be subject to more active conservation. Such areas have been established within the Important Plant Areas (IPA) Database, but exist only for a limited number of European countries. Species Action Plans for threatened species need to be drawn up and implemented, and national and European legislation should be revised. Conserving both inter- and intraspecific plant genetic diversity is important, as they may harbour important information, e.g. regarding responses to climate change (Schierenbeck 2017). Genetic information is important also for wild crop relatives, as they might become increasingly important in the future for crop improvement (Vincent et al. 2019). Also, there is a need for systematic gap analysis of all threatened and priority species to ensure they are being actively conserved both in situ and ex situ. There is a need to expand knowledge on European vascular plants, especially in underprivileged regions, such as e.g. the Balkan countries, which due to historical, sociological and economic reasons remained neglected for a long period, and where strong anthropogenic activity has modified plant genetic resources for eons. Only approximately 8% of Europe's plant species have been assessed according to the IUCN Red List Criteria (Bilz et al. 2011), thus the taxonomic coverage of the Red List needs to be increased, focusing especially on Data Deficient species. In order to improve future assessments and evaluate the impact of conservation measures and future environmental change, a coordinated system of vascular plant recording and monitoring needs to be established in every European country, improving our knowledge of population trends, which is currently lacking for many European plant species. New approaches, such as citizen science, could contribute to this. The network of European plant experts, established and young researchers, specialists in both wild plants and crop wild relatives - needs to be strengthened by providing training, improving communication, and mobilisation of financial resources.

1.2.2 OBJECTIVES

1.2.2.1 Research Coordination Objectives

The aim of this Action is to provide a sound base for long-term plant conservation by bringing together scientists, professionals including NGOs, policy makers and the general public. This will be achieved by including all aspects of plant conservation, from plant biology, ecology, genetics, in situ and ex situ plant management, legislation, as well as by including the important, but often neglected social aspects of plant conservation. Through this integrated approach, the Action will put theoretical knowledge about plant conservation into practice by bridging the gap between science, policy makers and the society.

Specific research coordination objectives will be:

• To identify knowledge gaps in plant conservation and their sustainable use, and promote best practices. The European continent bears regions with extremely high biodiversity, but these regions are often lacking appropriate resources, which result in inappropriate conservation strategies. For example, the IUCN Red List of European vascular plants largely neglects representatives of a large part of the Balkan flora (e.g. Former Yugoslavia, Albania). By including specialists from the whole Europe (and beyond, for instance in some of the centres of domestication of crop plants such as Armenia), the Action aims to bridge the gap in knowledge and experience among conservationists. A broad network of experienced plant conservationists will encourage countries who still follow the old categorisation of threatened plant species to harmonise their systems with the currently used IUCN categories.

• To identify and adopt novel and cutting-edge methodologies and approaches in plant conservation. With the rise of new scientific techniques (Next-generation sequencing, environmental modelling, remote sensing) plant conservationists are equipped with powerful tools to improve conservation. However, the application of these techniques is not yet very common in plant conservation. This COST Action will explore possibilities to incorporate novel tools into conservation planning.

• To harmonise and encourage the implementation of existing protocols and guidelines in plant conservation (e.g. germination protocols for the most severely threatened plants in Europe, protocols for seed collection, seed storage and reintroduction protocols). While several protocols regarding different aspects of plant conservation have been developed, stakeholders in the field (especially those coming from non-scientific background and/or from countries who invest little in plant conservation) are not familiar with them. Similarly, such protocols including action plans or rescue programs are often developed locally for each country or natural area and do not reflect the whole species' distribution.

Scientists and practitioners in the field need to communicate better in order to obtain positive conservation results. By sharing knowledge and know-how between participants (including reporting the successes and failures of reintroductions and related activities) this COST Action will enable to achieve better results in conservation actions.

• To identify the role and contribution of different stakeholders and the general public in plant conservation. Despite the importance of the ecological considerations, effective conservation planning must include also social considerations. However, the social aspects of conservation planning are in many cases neglected, and a poor understanding of the socioeconomic constraints and opportunities that shape implementation of conservation actions too often result in failures to implement concrete actions. Communication between different stakeholders involved in plant conservation will take conservation actions to a new level. In recent years, the expanding citizen science approach has offered citizens a more inclusive role in science (e.g. by development of rescue planting in private gardens, monitoring of species occurrence by inhabitants, school programmes). The Action aims to evaluate the potential initiatives undertaken by the general public in providing relevant information about threatened plants as well as providing conservation services. Since some of these actions dealing with the inclusion of general public in plant protection need permission by the law, legislative issues will be discussed to find the balance between radical species protection and allowance of legal participation of general public in species protection.

1.2.2.2 Capacity-building Objectives

The recognition of the need for plant conservation is widely acknowledged across the globe, but the lack of finances, adequate infrastructure, professional staff, and know-how in some countries, e.g. Inclusiveness Target Countries (ITC), prevents the establishment of sound and long-term plant conservation. Moreover, plants are often regarded as less attractive than animals from the general public point of view, usually due to their smaller size and immobility, and thus it attracts less resources for their research and conservation. The core capacity-building objective of this COST Action is to establish a functional network of scattered groups of conservationists to foster the sharing of knowledge, know-how and infrastructures in the field of plant conservation. This will be achieved by attracting a critical mass of researchers, institutions and other stakeholders from across Europe and beyond, with a special emphasis on ITC and COST Near Neighbour Countries, in order to improve conditions for plant conservation in those countries. The inclusion of stakeholders from ITC and COST Near Neighbour Countries will be encouraged throughout the duration of the project.

Specific capacity-building objectives will be:

• To develop an interactive platform containing data on past and on-going conservation actions implemented on threatened plant species and institutions dealing with plant conservation and concrete conservation actions on plant species. The platform will facilitate the exchange of knowledge and know-how exchange between different stakeholders dealing with plant conservation.

• To connect stakeholders dealing with plant conservation from different backgrounds, not only from biological sciences but also from social and law sciences and practical conservationists.

• To identify and promote conservation in biodiversity-rich regions that still lack such activities through facilitating the involvement of conservationists from countries with lower capacity in the topic of the Action.

• To connect institutions and promote the shared use of larger equipment and infrastructure (e.g. growth chambers, seed banks, germplasm collections, herbaria) to implement conservation activities and achieve specific conservation goals.

• To involve Early Career Investigators (ECI) in all activities of the Action, with a special focus on Short Term Scientific Missions (STSMs), through which they will be able to strengthen their connections with host institutions and acquire knowledge in special fields of plant conservation.

• To favour the involvement of the under-represented gender by equally distributing all functions within the COST Action (WG leaders and other functions within the COST Action).

• To promote the sustainability of the network beyond the life of the COST Action. The Action will establish sustainable synergies among European conservationists on how to do research on endangered plant species and how to conserve them in the long term. Moreover, the established network of members with similar research goals will improve the possibilities for successful application at international research projects, such as the Horizon 2020.

• To disseminate knowledge about the importance of plants and promote plant conservation among the general public.

The capacity-building objectives will lead to several outcomes and deliverables, such as the establishment of an interactive platform within the official COST Action website used by different stakeholders to overview conservation activities on threatened plants, including an interactive online map showing concrete conservation activities for distinct plant species in all Europe (and potentially beyond). Through its meetings, STSMs, workshops and training schools, the Action aims to establish a better connection between different stakeholders, resulting in the application of international projects. Meetings will result in published research and review papers, as well as in dissemination material for the scientific and general public.

2 NETWORKING EXCELLENCE

2.1 ADDED VALUE OF NETWORKING IN S&T EXCELLENCE

2.1.1 ADDED VALUE IN RELATION TO EXISTING EFFORTS AT EUROPEAN AND/OR INTERNATIONAL LEVEL

One of the strategic goals, adopted by the Convention of Biological Diversity (CBD) in Nagoya in 2010 (the so called Aichi Biodiversity Targets goals), is enhancing the implementation of the CBD through participatory planning, knowledge management and capacity building. Among the targets by 2020, knowledge, the science base and technologies relating to biodiversity (its values, functioning, status, trends and the consequences of its loss) should be improved, widely shared and applied. Also, the extinction of known threatened species should be prevented and their conservation status, particularly of those in decline, should be improved. Activities of the proposed COST Action are in line with the CBD recommendations (Global Strategy for Plant Conservation 2011-2020) and will be particularly important in light of the preparations for the Post-2020 Biodiversity Framework.

CITES regulates the international trade in endangered species and is legally binding to its parties. The trade for all the species listed in Appendix II should be controlled in the form of export permits and reexport certificates being required. TRAFFIC, the wildlife trade monitoring network, highlights the importance of wild plants for the sustention of millions of collectors around the globe, although these activities, also called “hidden harvest”, receive little attention from the public. Although the problem of wild harvesting and its consequential illegal trade is more well-known in tropical countries, it should not be neglected in other regions, even in Europe, where some ethnic minorities still rely on it as source of income. Juniper, wild garlic, thyme, sage, oregano, rosehips, mountain arnica, elderberries, blueberries, lime flowers or even dandelions and nettles are recognised as species of commercial interest. As several of these genera also include endemic species, uncontrolled collecting could lead to the potential loss of populations and subsequently species. By now, only 7% of medicinal and aromatic plants have been assessed against extinction criteria. In order to conserve plant species, the supply chain of wild plants should be moved towards sustainability. Furthermore, the EU Wildlife Trade Regulation (338/97) lists additional species to those included in CITES, which need management at European level.

On the European scale, the Bern Convention is one of the most important binding international agreements that aims to conserve wild flora, fauna and natural habitats, but also to promote the cooperation of European countries towards that objective. In the EU, the Bern Convention is implemented through the Habitats (92/43/EEC) and Birds Directive (2009/147/EC), which need to be transposed into the national law by the EU member states. In terms of species conservation impact, the most important Annex within the Habitats Directive is Annex II, which includes approximately 600 plant species of Community Interest whose conservation requires the designation of Special Areas of Conservation ("Natura 2000 sites"). Among these, approximately 200 are considered priority species in danger of disappearing for which there are specific rules.

LIFE Programme is the EU’s financial instrument supporting environmental, nature conservation and climate action projects throughout the EU, representing a cornerstone of plant conservation efforts, especially within the boundaries of the Natura 2000 network. Projects from the priority area Nature & Biodiversity support both in situ and ex situ conservation measures required to address the threat of extinction, but have also benefited whole areas and habitats, contributing to enhance biodiversity and thereby supporting the policy goals of the EU’s Biodiversity Action Plan and the EU 2020 Biodiversity strategy. LIFE projects have helped establishing seed and gene banks as well as conservation centres, where plants are raised and bred to have a stock of individuals for reintroductions or populations reinforcements. Among the many plant species conserved within the LIFE projects are e.g. Abies borisiiregis, Abies nebrodensis, Aster sorrentinii, Dianthus diutinus, Dictamnus albus, Limonium etruscum, Pinus cembra, Viola hispida and Biscutella neustriaca. Moreover, LIFE supports also dissemination activities and awareness raising within the priority area Environmental Governance & Information. Researchers involved in the preparation of this COST Action have participated in several LIFE projects focused on the rescue of threatened plants, and with this COST Action they will be able to share their experience and know-how with other participants and develop protocols for a better and more efficient conservation strategy.

While the LIFE Programme supports concrete conservation and dissemination activities, COST Actions mainly focus on strengthening cooperation between researchers and institutions. Up to now, very few have focused on nature conservation; most of them have concentrated on forest ecosystems (FP1206 European mixed forests - Integrating Scientific Knowledge in Sustainable Forest Management; ES1203 Enhancing the resilience capacity of SENSitive mountain FORest ecosystems under environmental change; FP1202 Strengthening conservation: a key issue for adaptation of marginal/peripheral populations of forest trees to climate change in Europe; E28 European Forest Genomics Network; E27 Protected Forest Areas), while conservation of threatened plants outside the forest ecosystem has been largely neglected. However, efforts related to plant conservation are included in COST Actions CA17122 - Increasing understanding of alien species through citizen science; TD1209 European Information System for Alien Species; FA1202 Strengthening conservation: a key issue for adaptation of marginal/peripheral populations (MaP-FGR) of forest tree to climate change in Europe, and FA1203 Sustainable management of Ambrosia artemisiifolia in Europe. These actions focus on invasive alien species, which pose a severe threat to biodiversity in general, and also to native threatened species.

The proposed COST Action will take advantage of the knowledge accumulated in the on-going and completed Actions, for example in CA17122, as the Action is aiming at exploring and developing the potential of citizen science, which will be one of the activities of the proposed Action. The Action will build on the experience of previous COST Actions relating to plant conservation, among which FA1307 Sustainable pollination in Europe - joint research on bees and other pollinators is especially important. Within the European Community's Sixth Framework Programme, the ENSCONET (European Native Seed Conservation Network) was established with the aim to conserve native seed plant within Europe. This COST Action will take advantage of the ENSCONET established network and results by integrating them into the proposed Action, but avoiding the possible duplication of activities.

2.2 ADDED VALUE OF NETWORKING IN IMPACT

2.2.1 SECURING THE CRITICAL MASS AND EXPERTISE

The initial network was composed of 42 proposers affiliated with 32 different countries, which ensures the critical mass of proposers, expertise and geographical coverage of the region (extending even beyond Europe). The Network established within this Action is composed of leading specialists in all fields of plant conservation (e.g. taxonomy, conservation genetics, pollination biology, ex situ and in situ conservation, among others), dealing both with theoretical and practical questions about plant conservation. While researchers will provide the theoretical knowledge and background of plant conservation, people dealing with concrete actions, such as reintroductions or habitat restoration, will cover the practical aspects of plant conservation. Expertise however increases with each new participating institution from the relevant field; therefore, the constant growth of the Action network will be warmly encouraged.

2.2.2 INVOLVEMENT OF STAKEHOLDERS

The heterogeneous composition of the network of proposers, composed of universities, research institutions, botanical gardens, museums, NGOs and ministries/governmental bodies will ensure the strategic outreach of the activities, as each institution type is linked to its own network of collaborators. The research institutes and universities will be involved in the synthesis of existing data and generation of new knowledge from the broad field of plant conservation. The transfer of scientific knowledge to conservation managers and practitioners, which is currently poor, needs to be improved. By providing conservation managers and practitioners with lists, protocols and scientific and technical reports, which will be also available freely on-line, they will help them to improve conservation activities. Universities will have the important task to disseminate knowledge and experience in plant conservation to graduate and postgraduate students, the future theoretical and practical conservationists, but also to the general public through popular science articles. The participating NGOs, which work in the field of both education and also perform concrete conservation actions, will involve the general public of all ages, from children to grown-ups, and encourage and engage them in conservation activities, also through the citizen science approach.

2.2.3 MUTUAL BENEFITS OF THE INVOLVEMENT OF SECONDARY PROPOSERS FROM NEAR NEIGHBOUR OR INTERNATIONAL PARTNER COUNTRIES OR INTERNATIONAL ORGANISATIONS

The Network initially includes three Near Neighbour Country Institutions: Armenia, Lebanon and Ukraine. Southern Europe represents an area of high diversity of species and highest number of endemic and threatened plants, and the same is true for the Caucasus. Distribution ranges of plants are not restricted to state borders, and conservation of species should include the whole species range of threatened plants. It is therefore important to include proposers from the bordering regions, as this will give a chance of collaboration and knowledge sharing in a broader biogeographical context and will connect experiences from Europe, to the wider Mediterranean basin biodiversity hotspot and even further to the Caucasus biodiversity hotspot.

3 IMPACT

3.1 IMPACT TO SCIENCE, SOCIETY AND COMPETITIVENESS, AND POTENTIAL FOR INNOVATION/BREAKTHROUGHS

3.1.1 SCIENTIFIC, TECHNOLOGICAL, AND/OR SOCIOECONOMIC IMPACTS (INCLUDING POTENTIAL INNOVATIONS AND/OR BREAKTHROUGHS)

Scientific impacts will include the upgraded knowledge of species biology, habitat requirements, conservation status, abundance, pollinators, mutualists and antagonists of the most threatened European plants; but also the improved quality and accessibility of data. From the technological point of view, the Action will establish an interactive platform gathering all available information on past and existing actions on threatened European plants, their distribution, biology, threats, existing management and conservation plans, links to scientific papers and grey literature. Also, the Action will help with the identification of up-to-date genetic and genomic technologies in plant conservation with recommendations concerning pros and cons (e.g. costs, sample sizes, source material, explanatory power) and to develop protocols to integrate genetic diversity of endangered plant species into existing EU biodiversity policy (IUCN Red Lists, National Red Lists etc.). Socioeconomic impacts include improved communication between scientists and practitioners, which will lead to a more successful plant conservation and thus healthier environment, and improved knowledge transfer to ITC and Near Neighbour countries. Local people and ethnic communities will be educated about the potential threats to plants posed by unsustainable harvesting. Participation of the general public in plant conservation will be strongly encouraged. Among the potential innovations will be the setting up of lists of priority plant species for protection, followed by the development of coordinated action plans based on scientific knowledge for protection of specific species at the European level. For the first time, the distribution of priority threatened species will be mapped against protected areas to identify threatened species not covered by any level of protection and to guide the development of new protected areas. Moreover, specific approaches to include the general public in plant species conservation (based on citizen science approaches) will be developed and established.

3.2 MEASURES TO MAXIMISE IMPACT

3.2.1 KNOWLEDGE CREATION, TRANSFER OF KNOWLEDGE AND CAREER DEVELOPMENT

The COST Action will have a high impact on researchers, enabling them to cooperate with other specialists dealing with similar problems. Regular MC and WG meeting will represent the source of networking and the meeting point to discuss recent developments in the field. Early Career Investigators (ECI) from underprivileged countries, such as some ITC or Near Neighbour Countries, will be able to attend conferences through ITC Conference Grants, which will have a high impact on their career development. Involvement in STSMs will enable them to connect and work with top specialists from relevant fields. Plant conservation requires not only new scientific insights, but also gaining practical know-how and its transfer to young conservationists. This will be enabled by organising workshops, training schools and visits to centres dealing with practical conservation activities. ECIs will be able to communicate and meet with persons from national and international organisations resulting in potential employment opportunities.

3.2.2 PLAN FOR DISSEMINATION AND/OR EXPLOITATION AND DIALOGUE WITH THE GENERAL PUBLIC OR POLICY

A comprehensive dissemination plan will be developed by the Management Committee at the beginning of the COST Action (Table 1). General dissemination of all Action activities and accomplishments will be done through the Action website, which will be developed within the first year. Through the establishment of social media accounts on Facebook, Twitter and Instagram, the Action will be able to reach also to users that were not considered in the first place, such as local conservation associations, botanical gardens with ex situ cultures, and individual enthusiasts.

Table 1.

Plan for dissemination and/or exploitation

TARGET GROUP	WHAT?	HOW IT WILL BE ACHIEVED?
Researchers / Conservation scientists	Sharing knowledge with other researchers.	By publishing joint peer-reviewed articles (including review articles), by presenting research at conferences and by organizing workshops.
Young conservationists (MSc and PhD students)	Gaining pan-European conservation knowledge.	By taking part in STSMs and ITC conferences, by inviting them to attend relevant workshops.
Conservation managers and practitioners	Transfer of knowledge to conservation managers and practitioners.	By publishing technical reports and newsletters, by providing guidelines, by inviting practitioners to workshops, by inviting them to take part in STSMs and ITC conferences.
Policy-makers	Providing them with scientific opinion on all levels - national, regional, EU and global.	By inviting them to events organised by this Action (e.g. meetings, workshops).
	Acquainting them with outcomes of the Action.	Through social media, the Action website and newsletters.
	Demonstrate the importance of plants and their conservation for the achievement of the Sustainable Development Goals (SDGs) and other policies.	By taking part in field workshops, by policy briefs, conservation policy events linked to EC events, by reports / letters sent at regular periods to local policy makers and by inviting them to workshops and training schools.
Citizens	Involving them in conservation activities (e.g. help with gathering information about the distribution of threatened species, garden cultivation of threatened species).	Through social media, through articles in national and international printed and digital newspapers, through the Action website, and through focus groups aimed at gathering the perception of the citizens about plant conservation.
	Informing citizens about the importance of conserving plants and their natural habitats.	

4 IMPLEMENTATION

4.1 COHERENCE AND EFFECTIVENESS OF THE WORK PLAN

4.1.1 DESCRIPTION OF WORKING GROUPS, TASKS AND ACTIVITIES

Working Group 1: Improving knowledge in plant biology for appropriate in situ conservation

Conservation actions, particularly in plants, often lack in-depth knowledge of various aspects of plant biology, ecology, population dynamics and conservation genetics. If these aspects are not carefully considered when planning conservation actions, the result of such actions is probably poor (Heywood and Iriondo 2003). Even though information about specific aspects of threatened plants (e.g. their biology, mutualists and antagonists, including pollinators, seed dispersers, herbivores, and their genetic diversity) and the threats they are facing (e.g. habitat loss, habitat deterioration, invasive species, beekeeping and lack of pollinators) is partly available within the scientific community, the transfer of knowledge to practitioners is poor. The main aim of this WG is to improve this knowledge transfer by gathering all relevant information about European threatened plant species and make this information publicly available as well as to find more effective channels to communicate this information to conservation practitioners. The main achievement of this WG will be the establishment of a platform including available information on existing conservation actions implemented on threatened plants included in conservation programmes. This platform will include data on distribution and abundance, biology, threats, past and/or current land-use and existing management and conservation plans, links to scientific papers and grey literature, and last but not least information about institutions dealing with different threatened species in European countries. This will be possible due to the fact that 32 countries are currently supporting this COST Action, with more being expected to join in the first three years of the Action. Moreover, in order to recognize future challenges, data gathered over a large geographic scale and the use of spatial modelling will allow us to predict the potential performance of the most severely threatened European plants in the future.

Task (1.1): Evaluation of species-based approaches aimed at providing plant conservation actions. Recognition of the importance of mutualists (including pollinators) and antagonists for plant conservation. Review the specific uses of the life cycle data and suggest guidelines for wider use of these data in practical conservation.

Task (1.2): Identification of the potential uses of population biology, conservation genetics and genomics in conservation actions.

Task (1.3): Identification of optimal strategies for habitat/site management to keep and improve the favourable conservation status of endangered species and identification of invasive plants posing a threat to European threatened plants.

Task (1.4): Identification of the role of changes in landscape utilization and current management in in situ conservation.

Task (1.5): Use and manipulation of spatial data to provide proper conservation measures for European threatened plants together with prediction of species survival in the context of climate change.

Activity: Establishment of a joint European interactive platform containing data on conservation actions on threatened plant species and institutions dealing with plant conservation and concrete conservation actions.

Activity: Creation of a list of pollinators of European threatened plants.

Activity: Review paper of the use of genetic and genomic information in conservation of European threatened plants and their integration into management, conservation plans and regulatory framework.

Activity: Review of changes in landscape utilization and management throughout Europe in the light of political and sociological changes over the last century.

Activity: Modelling of environmental suitability and species performance for selected plants with the highest risk of extinction under future climate change.

Working Group 2: Sharing experience in plant ex situ conservation

Ex situ conservation within herbaria, seed and germplasm collections and botanical gardens, represents a crucial conservation approach (Volis 2017, Liu et al. 2018, Godefroid et al. 2011c), especially when in situ conservation cannot be applied. However, in the field of conservation, the rationalization of financial resources has become a crucial problem. In this unfavourable context, local authorities are frequently reluctant to release funds for the development of ex situ programs, in particular because many of them are not convinced of the value of ex situ conservation. One of the main points of criticism of ex situ conservation is the supposedly low genetic quality of the collections (Guerrant et al. 2014, Ensslin et al. 2015). Studies comparing the genetic diversity of ex situ collections with that of wild populations exist in a dispersed manner and require a comprehensive synthesis in order to have a more precise idea of the actual situation. Furthermore, up-to-date protocols, which aim to ensure the capture of genetic diversity during seed sampling and plant propagation, are not well distributed across the countries and institutions. To respond effectively to European conservation policies (e.g., art. 11.2 of the Bern Convention, art. 22 of the Habitats Directive 92/43/EEC), translocations must inevitably increase to enable species to colonize habitats that they are unable to reach by natural dispersal. Case studies, best practice and experiences of plant reintroductions are however not well-synthesized, lack crucial and precise implementation manuals and are not sufficiently disseminated to the plant conservation community, most often remaining in unpublished internal reports to which access is difficult. We suggest that this is a major problem for conservationists.

Task (2.1): Providing concrete evidence of the importance of an integrated approach to species conservation.

Task (2.2): Analysis of ex situ programmes throughout Europe (e.g. seed banks and existing initiatives for joint seed banks, germination protocols, plant ex situ conservation activities in European botanical gardens).

Task (2.3): Assessing the genetic quality of ex situ collections relative to wild populations.

Task (2.4): Analysing the current state of plant translocations actions across Europe.

Activity: Review of cases where in situ protection measures have proved insufficient or ineffective for the conservation of endangered species.

Activity: Drafting of a synthetic document in several European languages intended to land management authorities, government agencies and local stakeholders, gathering formal evidence about the effectiveness of and necessity to develop ex situ conservation programs.

Activity: Review of scientific studies analysing the genetic integrity of ex situ collections.

Activity: Provide guidelines on good practices aiming at optimizing ex situ conservation management.

Activity: Share current protocols that aim to maximise the preservation of genetic diversity during seed sampling in the wild, as well as keeping this diversity during ex situ storage, propagation and cultivation. Discussion of hands-on examples of the implementation of those protocols, e.g. in botanic gardens and conservation agencies.

Activity: Review of literature and unpublished cases related to plant translocations.

Activity: Identify, develop and share best practice protocols to maximise reintroduction success.

Activity: Identify potential inconsistencies when considering species translocations at a supra national scale across participating countries of the COST Action.

Activity: Provide harmonization of priorities between countries and regions and promote the establishment of translocation programs at relevant biogeographical scales throughout Europe.

Working Group 3: Filling the gaps in plant conservation

A lack of coherence in plant conservation is an ongoing problem within European countries. There are significant differences between regions and countries within regions in financial resources and human expertise. As a consequence, there is a gap of data for some European regions. Moreover, an additional issue in plant conservation is represented by the inconsistency between red list criteria among different countries (Bachman et al. 2019). In most countries, red list criteria follow the IUCN categories. However, these have changed throughout the years, while national red list categories sometimes follow the old categorisation. In order to make categories comparable between countries, countries should be encouraged to harmonise their categorisation with IUCN and re-evaluate their species accordingly (IUCN 2012, Gardenfors et al. 2001). Some criteria are also not yet implemented in the IUCN list; historic bottlenecks are not mentioned, slow population declines are not considered a threat, there are no differences between rare but stable species and declining species, plants with different life forms and life spans are treated similarly, etc. Beside this, there are also lists of protected and strictly protected species on national or regional level that do not have to be strictly connected with IUCN but are even more thoroughly regulated by national legislations (Brito et al. 2010).

Task (3.1): Review of the state of the art of red list categories within European countries and ways for potential harmonisation with IUCN categorisation.

Task (3.2): Identification of threat criteria, which are not yet implemented in the IUCN list.

Task (3.3): Determination of European threatened plant species in urgent need for conservation actions at national, transnational and regional level.

Task (3.4): Divide species in urgent need for conservation to: a) species, for which conservation is feasible since we have sufficient data about species biology, habitat requirements and current quality, as well as, adequate management plans; b) species with sufficient data, but that are not included in management plans; c) species without data about their biology: d) species for which conservation is not feasible even in long term.

Task (3.5): Review of national legislations and recognition of gaps and overlaps with international conservation lists and agreements.

Task (3.6): Review of management plans and other methods used for plant rescue to identify gaps in the knowledge about target species (which information is missing in practical conservation). Suggestion of changes in management plans and methods or preparation of research project aimed to missing knowledge.

Task (3.7): Bring researchers together to develop projects for the conservation of the identified priority species not previously addressed.

Activity: Preparation of a scientific report showing the comparison of red lists across Europe and identification of countries whose red list have not yet been harmonised with IUCN.

Activity: Attempt to initiate collaboration with local or international organisations responsible for the national red lists to foster harmonisation of threat categories across Europe.

Activity: Analysis of European national and international red lists to develop a consolidated list of priority species for conservation at regional level.

Activity: Preparation of a list of the most threatened plant species in urgent need for conservation actions within each participating country.

Activity: Development of a consolidated list of priority species for conservation at regional level.

Activity: Establishment of a list of priority species in need of transnational conservation.

Activity: Analysis of plants included in protected species lists according to national laws.

Activity: Evaluation of effectiveness of current management plans and their practical implementation on the rescuing of selected plant species

Working Group 4: Human dimension in plant conservation

Despite the indisputable importance of vascular plants as part of ecosystems and their role in ecosystem services, there is no doubt that animal species, especially e.g. large mammals, are more popular within the general public, and, thus, are frequently used as flagships in conservation marketing campaigns. In this respect, plants attract much less of the public's attention and financial resources than animals.

Although conservation funding shows strong bias towards some species, a recent study showed that additional marketing can have a large impact on donor behaviour (Veríssimo et al. 2017), potentially significantly increasing the interest of donors towards less appealing species. Appropriate marketing could thus have a large impact on donor behaviour and could increase funding for a much wider range of species, including plants. In this view, citizen science campaigns could act as marketing initiatives attracting people’s attention toward threatened plants and help with their actual conservation (Chen and Sun 2018, Chandler et al. 2017Steven et al. 2019). However, successes and failures of conservation activities are not dependant only on funding, but also on the coordination of these activities between different stakeholders.

Furthermore, another aspect that should not be neglected when planning conservation activities and producing conservation plans is the consideration of plant exploitation by citizens and ethnic minorities. In Europe, particularly in the Mediterranean region, traditional use of plant resources is present since ancient times. For example, plants are collected for consumption, production of beverages, and traditional medicines by local indigenous communities and by citizens. While occasional collecting of species usually does not pose severe threats to most plants, threatened plants could be affected (Lange 2001).

Similarly, many threatened species are collected by gardeners directly in the nature. The issues of wild plants collecting, including legal and illegal trade of rare species and medical plants, should be carefully considered in the light of their conservation.

Task (4.1): Overview of actual and potential human uses of European threatened plant species.

Task (4.2): Review of current citizen-science projects focusing on plant conservation and evaluation of potentials of novel approaches to plant conservation (e.g. involvement of ecotourism).

Task (4.3): Identification of potential funding sources for plant conservation on national, regional, EU and international level.

Task (4.4): Conservation role of flagship plant species throughout Europe.

Activity: Preparation of a report on the socio-economic aspects (edible plants, medical plants, economic importance, cultural importance, collectable plants etc.) of European threatened plant species and their potential and actual effects on their conservation status.

Activity: Preparation of a report on citizen-science plant conservation projects.

Activity: Preparation of a report containing best practices of promoting plant conservation through ecotourism and similar activities and dissemination between interested stakeholders.

Activity: Preparation of a comprehensive list of funding sources (e.g., projects, scholarships.) on national and European level.

Activity: Review of existing citizen initiatives to promote local endemics and threatened plant with a role of flag species and their role in conservation strategies.

Working Group 5: Genomic approaches in plant conservation

A whole new subfield of plant conservation, conservation genetics and genomics is underway. The evolution from conservation genetics to genomics is timely in elucidating the interplay between climate change and plant adaptation. Conservation genomics will lead to the identification of genomic regions that may have undergone selection and are of adaptive significance (therefore of particular importance for conservation), while improving the precision of genetic and demographic inferences (Aravanopoulos et al. 2015). WG5 will review approaches such a gene conservation unit selection, assisted migration and translocation, looking into the contribution of genomics to their application and to the thorough assessment of the potential consequences of their implementation. Regarding ex situ conservation, WG5 will investigate the use of genetically representative ex situ collections (Hoban and Strand 2015), especially for the most critically threatened species, as conservation genomics offers unparalleled means in assessing and ensuring the genetic representation of ex situ collections. While new studies are emerging, their results are still not being frequently incorporated into plant conservation. Such studies have important management consequences regarding the conservation of natural genetic variation and on rare/threatened species/populations, in light of in situ protection, selection of plant material for ex situ conservation, assisted migration, and reintroduction/ reinforcement of extant germplasm.

The main aims of this WG are: (1) to evaluate the potential of conservation genomics, and (2) to denote the implementation of pertinent results into practical plant conservation (Shafer et al. 2014). The main achievements will include determining the potential of novel genomic technologies in conservation, documenting the use of genomics in conservation actions, and integrating genomics into management/conservation plans. This will be achieved by promoting genomic-related approaches, i.e. evaluation of laboratory and field sampling protocols, training schools and workshops, best practice approaches/ technologies, and recommendations for conservation managers focusing on genetic diversity.

The main Tasks of Working Group 5 are:

Task (5.1): Identification of the potential applications of conservation genetics and genomics in in situ conservation actions.

Task (5.2): Identification of the potential applications of conservation genetics and genomics in ex situ conservation actions.

Task (5.3): Documentation of the use of landscape genetics and genomics for plant conservation of threatened species, as well as threatened populations (such as marginal and peripheral populations) of otherwise non-threatened species.

Task (5.4.): Translation of conservation genetics and genomics results in the management of plant genetic resources.

The main Activities of Working Group 5 are:

Activity: Development of a database on genetic and genomic data to support plant conservation. Deposit of papers related both the theoretical aspects of conservation genetics and genomics and their application in in situ and ex situ conservation.

Activity: Review paper on landscape genetics and genomics for plant conservation of threatened populations and/or species,

Activity: Review paper on local adaptation, gene flow, mating systems and connectivity.

Activity: Development of a position paper and/or policy brief and or popular communiques on the use of conservation genetics and genomics in the applied conservation of plant genetic resources.

Activity: Developing interactions with other research projects (such as the H2020 project GenTree http://www.gentree-h2020.eu/ and the LIFE+ project LIFEGENMON http://www.lifegenmon.si/), and other COST Actions (such as COST Action CA18134 G-BIKE https://www.cost.eu/actions/CA18134).'

4.1.2 DESCRIPTION OF DELIVERABLES AND TIME FRAME

Deliverable 1. Establishment of an interactive platform gathering data on past and on-going conservation actions implemented on threatened plant species. The contents of the platform will be developed within the activities of WG1 and WG2. By month 36.

Deliverable 2. List of pollinators, mutualists and antagonists of the most threatened European plants. The list will be produced within the activities of WG1 and will be published online. By month 24.

Deliverable 3. Lists of threatened plant species. Relevant lists (e.g. Species in urgent need for conservation actions within each participating country; Species for conservation at regional level; Priority species in need of transnational conservation) will be developed within WG3 and published on the website of the project. By month 18.

Deliverable 4. Yearly report for year 1. The report will report the progress of all four working groups (WG1, WG2, WG3, WG4) within the first year. By month 13.

Deliverable 5. Yearly report for year 2. The report will report the progress of all four working groups (WG1, WG2, WG3, WG4) within the second year. By month 25.

Deliverable 6. Yearly report for year 3. The report will report the progress of all four working groups (WG1, WG2, WG3, WG4) within the third year. By month 37.

Deliverable 7. Yearly report for year 4. The report will report the progress of all four working groups (WG1, WG2, WG3, WG4) within the fourth year. By month 48.

Deliverable 8. Material for training school "Conservation genetics and genomics of threatened plants" (WG1). By month 10.

Deliverable 9. Material for training school "Flowers and pollinators: field and lab techniques to assess functionality for biodiversity conservation" (WG1). By month 18.

Deliverable 10. Material for training school "From ex situ to in situ - challenges in plant material transfer" (WG2). By month 28.

Deliverable 11. Material for training school for people/institutions who communicate nature protection (e.g. info-centres, clubs of natural science...) introducing plant biology and ecology, ex situ conservation and citizen-science approaches (WG4). By month 40.

Deliverable 12. Conservation guidelines for appropriate ex and in situ conservation measures for conservation practitioners (WG1 and WG2). By month 48.

Deliverable 13. Ten popular-science and/or technical articles published in newspapers or dedicated websites (WG1,WG2, WG3, WG4). By month 48.

Deliverable 14. Peer-reviewed publications published in year 2 (e.g. Inconsistencies between the red list categories across Europe (WG3); Changes in landscape utilization and management throughout Europe in the light of political and sociological changes over the last century (WG1)). By month 24.

Deliverable 15. Peer-reviewed publications published in year 3 (e.g. Genetic integrity of ex situ collections (WG2); Existing citizen initiatives regarding conservation of threatened plants (WG4); Use of genetic and genomic information in plant conservation (WG1)). By month 36.

Deliverable 16. Peer-reviewed publications published in year 4 (e.g. Insufficient or ineffective measures for the conservation of endangered species (WG1), Plant translocations (WG2); Best practices of promoting plant conservation through ecotourism and similar activities (WG4)). By month 48.

Deliverable 17. List of funding sources for plant conservation (WG4) published on the Action website. By month 9.

Deliverable 18. Material for participants of the workshop on ex situ conservation (WG2). By month 21.

Deliverable 19. Material for participants of the workshop on the usefulness of citizen-science approaches (WG4). By month 30.

Deliverable 20. Material for participants of the workshop “Theoretical introduction and practical implementation of conservation activities for conservation managers and practitioners” (WG4). By month 39.

Deliverable 21. Material for participants of the workshop “Management interventions and their effectiveness” (WG3). By month 42.

The material for the Training Schools and workshops will be available on the website of the Action.

4.1.3 RISK ANALYSIS AND CONTINGENCY PLANS

Potential risks:

• Quality of established network. The established network includes experienced researchers from different fields of plant conservation. Several of them worked together in some previous research cooperation, which ensures a smooth course of this Action. Proposers who were involved in the preparation of the proposal have shown great interest from the beginning, as sharing knowledge and experience when dealing with concrete conservation actions is crucial for the successful implementation of the actions. Since COST Actions are open during the first three years of the implementation of the Action, we expect that many new participants/institutions will join this Action, ensuring an even higher impact.

• Logistical problems due to the large number of network partners (especially in the view of proper reporting). Action MC will discuss the best option for organizing events (such as WG meetings, training schools etc.).

• Low participation in Action activities, such as workshops, STSMs. The proposers of the Action will be asked to forward the information about training schools, workshops and STSMs through their websites, social media and mailing lists.

• Geographically uneven distribution of partners, leading to gaps in knowledge. The proposed COST Action includes a large percentage of European countries, minimising the risk of such uneven distribution. In the first years of the Action, special efforts will be driven to the inclusion of partners from missing countries, but also to Near Neighbour Countries and international partners, which are important for the integrative conservation of threatened species occurring in European and Near Neighbour Countries.

• Delay in submitting deliverables. Participants of each WG will be asked to follow the appointed schedule proposed in the COST Action.

• Gender imbalance and low involvement of early stage researchers. Special attention will be put to inclusion of young researchers and equal representation of genders in MC, WG leaders and STSMs.

• Language barriers. While the scientific community is used to communicating in English, other stakeholders (e.g. conservat ion managers) usually communicate in their native languages. The Action will aim to produce multilingual materials wherever possible and encourage multilingual abstracts in scientific papers.

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